

Nicholas C. Metropolis



Nicholas C. Metropolis, a giant of mathematics and one of the founders of the Information Age, described himself as a mathematician “enamored of logic.”

An original scientist of the Manhattan Project, Metropolis was at the center of many of Los Alamos National Laboratory’s early achievements. He is best known for his contributions to the Monte Carlo mathematical method, fundamental to applying the laws of probability to science, and more generally to the field of integro-differential equations that are important in nearly every branch of the natural sciences.

Metropolis also is known for carrying forward John von Neumann’s principle of the stored program to develop one of the world’s first high-speed electronic digital computers, which he named the mathematical and numerical integrator and computer, or MANIAC. Metropolis often said he chose an absurd acronym to put an end to the scientific practice of attaching acronyms to everything. Ironically, the acronym not only stuck, it probably exacerbated the acronym fad.

Born June 11, 1915, Metropolis grew up on Chicago’s west side. He came to the Laboratory in April 1943, after

earning his bachelor’s degree (1936) and doctorate (1941) in experimental physics from the University of Chicago.

J. Robert Oppenheimer recruited Metropolis from Chicago, where he was collaborating with Enrico Fermi and Edward Teller on the first nuclear reactors. His first assignment at Los Alamos was to develop equations of state for materials at high temperatures, pressures and densities. In a 1985 interview, Metropolis remembered those early days. “Undoubtedly, this was the most marvelous experience a scientist, young or old, could have ever imagined. All the great minds in science were assembled here or visited frequently. It was fabulous to be listening to all these great scientists. The experience was electrifying.”

Since all the calculations needed to develop the first atomic bombs had to be done on slow, electromechanical calculators, Metropolis and Richard Feynman spent some of the war years repairing calculators, and even hung out a shingle for their repair “business.”

Computing at Los Alamos during the war evolved from these hand calculations through punched-card computation to the electronic computing in

whose development Metropolis was instrumental. He was present at Oppenheimer’s dramatic final colloquium before the Trinity test and at the detonation of Trinity on July 16, 1945. He recalled traveling through a tremendous thunderstorm on the bus to Alamogordo. “The lightning was so intense that many of us on the bus thought that the others had not waited for us, that they had tested the bomb,” Metropolis said.

He returned to Chicago as an assistant professor after the war, coming back to the Laboratory in 1948 to start and lead the group in the Theoretical Division that designed and built MANIAC in 1952 and, five years later, MANIAC II. He returned to the University of Chicago in 1957 to found and direct the university’s Institute for Computer Research, but came back to Los Alamos in 1965.

During this final stint at Chicago, he was instrumental in developing imaginative new uses for computing, including the important invention of on-line data processing in scientific experimentation. He designed and built, with a soldering iron in his hands, a computer that directly received and analyzed data from the Navy cyclotron, permitting researchers to modify their experiments during their allotted time. He was also active in organizing the data and storing the results on nuclear structure, a rapidly developing field of physics at the time.

Metropolis became a senior fellow of the Laboratory in 1980 and in 1987 became the first Los Alamos employee honored with the title “emeritus” by the University of California. He was awarded the Pioneer Medal by the Institute of Electrical and Electronics Engineers and was a member of the American Academy of Arts and Sciences, the Society for Industrial and Applied Mathematics and the American Mathematical Society and a fellow of the American Physical Society.

Metropolis died Oct. 17, 1999, at the age of 84.



A wall in the Metropolis Center depicts some of the many contributions made by Nicholas C. Metropolis during his long and brilliant Los Alamos career.

The Nicholas C. Metropolis Legacy

by his colleague James D. Louck,
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Nicholas C. Metropolis was born June 11, 1915, third of seven children, four brothers and three sisters. His parents emigrated from Greece and were working-class Americans in Chicago. He spoke only Greek until he entered elementary school, where he was soon identified as precocious. He was a member of the swim team in high school, and set a school record in the butterfly stroke. He also was an avid and lifelong tennis player and skier.

Nick went through undergraduate and graduate school at University of Chicago, where he received his doctorate in 1941 in the then-emerging field of quantum chemistry under Robert S. Mulliken, Nobel laureate in chemistry in 1966. After working for a short period in 1942 with Harold Urey at Columbia, he became a member of Chicago's Metallurgical Laboratory. This association brought him to Los Alamos in April 1943, along with many other members of Enrico Fermi's group that had proved, in the famous graphite-pile experiment under the stands of Stagg field, that the multiplication of neutrons made feasible the explosive release of nuclear energy.

During the war years and the development of the atomic bomb, it became clear that accurate and fast numerical calculations were required for continued development of the physics of nuclear weapons. The Marchant hand calculators that Metropolis and Richard Feynman maintained for use during the war would not do the job. The ENIAC, developed by John Mauchly and Presper Eckert at the Moore School of Engineering at the University of Pennsylvania with John von Neumann consulting, set the stage for modern computing stratagems, as set forth by the genius of von Neumann.

To my knowledge, the first mention of Metropolis in connection with non-mechanical computing comes in early



Metropolis (right) and a colleague ponder chess moves in front of the MANIAC or mathematical analyzer, numerical integrator and computer.

1945 when he and Stanley Frankel traveled to Philadelphia to meet with John Mauchly and J.P. Eckert to discuss the ENIAC and determine its suitability for physical problems beyond the ballistic trajectories for which the ENIAC had been designed. Out of these post-World War II interactions and the fast-growing needs of Los Alamos to meet challenging defense requirements was born the first MANIAC — mathematical analyzer, numerical integrator and computer.

MANIAC I became operational in 1952. The opening of the Nicholas C. Metropolis Center for Modeling and Simulation comes on the fiftieth anniversary of this achievement.

Los Alamos not only built the machines themselves and thus influenced commercial computing, but perhaps more significantly initiated effective mathematical techniques for carrying out calculations and methods for instructing, or programming the machines. It is remarkable that Ulam, Metropolis and von Neumann in the late 1940s and early 1950s produced mathematical techniques, known as The Monte Carlo Method and the Metropolis

Algorithm, of such penetrating depth that they are mainstream methods of calculating to this day, in the very supercomputer being installed in this building.

The paper that set forth the technique known as the Metropolis Algorithm has been cited more than 6,000 times by other researchers, and was cited by the journal *Computing in Science and Engineering* as one of the 10 algorithms with the "greatest influence on the development and practice of science and engineering in the 20th century."

Why has Metropolis been honored by having a building named after him, a first for the Laboratory and the University of California? It is because over the entire landscape of the computer revolution, from its initial building to its logical operations to its multipurpose uses to its parallel unitary capabilities, one sees the imprint of Metropolis.

Director John Browne, following Metropolis' death on Oct. 17, 1999, wrote: "Nick's work in mathematics and the beginnings of computer science forms the basis for nearly everything the Laboratory has done in computing and simulation science."



Los Alamos National Laboratory is operated by the University of California for the U.S. Department of Energy's National Nuclear Security Administration